

[001] SHIFTING DEVICE FOR A TRANSMISSION

[002]

[003]

[004] The invention relates to a shifting device with the characteristics of the preamble of patent claim 1.

[005]

[006] Due to DE 41 37 143 A1, we are familiar with a multi-step synchronized countershaft, in which two gears each are assigned to one of several gearshift packages. These gearshift packages generally consist of sliding collars which can be moved axially, but are torsion-resistantly arranged on a gearbox shaft which, in joint action with synchronic rings that are located close to these sliding collars on the shaft, brake and accelerate loose gear wheels, and can connect rotation-resistantly with this gearbox shaft.

[007] In this transmission, the two gears (1st gear and 3rd gear or 2nd and 4th gear), which are allocated to a gearshift package, do not follow each other. This gear design has the advantage that it creates a gearshift system, which allows for an overlapping shift actuation and thus reduces the amount of time it takes to shift gears. A disadvantage is, however, that such a gear with a shifting device with H-gear shifting gate is difficult to shift, because normally only successive gears are shifted in the same gearshift path with an H-gear shifting gate.

[008] Furthermore, due to EP 10 34 384 B1, one is familiar with a twelve gear gearbox for utility vehicles. In this gearbox, a pre-shifting module is shifted manually, whereas the main or top shifting modules are shifted automatically. Pneumatic shifting devices are designed for the main shifting module and the top shifting module and are activated when the gearshift path of the desired gear is selected through the respective manual shifting device. Thus, the shifting diagram corresponds with the shifting diagram of a regular six gear gearbox. The disadvantage of this gear design is, however, that separate pneumatic shifting devices have to be provided for in order to be able to shift the gears the way it is usually done in an H-shifting diagram.

- [009] Furthermore, we are familiar with a shifting device for motor vehicles from DE 30 00 577, in which a manual shift lever is shifted in an HH-shifting diagram. In this shifting device, two shift fingers are arranged on the selector shaft in such a way that only one shift finger each shifts the four gears of the basic transmission. When changing from the second into the third gearshift path, a pilot valve is actuated, which shifts the range. When shifting into the third and fourth path, the second shift finger is engaged. A disadvantage here is also the separate actuator mechanism of the transmission range.
- [010] DE 35 27 390 A1 also shows a manually shiftable, double clutch transmission in which one of the two clutches of the double clutch is engaged when the gearshift lever is actuated in one gearshift path. The disadvantage of this shifting device is that it is limited to only four forward gears when shifting purely manually without any additional power source.
- [011] Finally, a shifting device for a transmission is described in the unpublished DE 102 31 547 A1 in which at least one gearshift package is allocated to two non-successive gear transmission ratio steps of the transmission. This shifting device is equipped with a mechanical conversion device which enables the one manual contactor with an H-gearshift frame to shift such a transmission.
- [012] In this shifting device, the gearshift lever is guided in an H- or multiple-H-gearshift frame and coupled with gearshift shafts so that a movement of the gearshift lever in a gearshift path causes the gearshift shaft to swivel around its longitudinal axis. Furthermore, a gear wheel is mounted on the first gearshift shaft, which combines with a second gear wheel on a second gearshift shaft. When the first gearshift shaft rotates, the second gearshift shaft counter-rotates in the other direction. When selecting a gearshift path with the gearshift lever, the two gearshift shafts are forced to couple parallel to their longitudinal axis.
- [013] Furthermore, these two gearshift shafts have shift fingers which, depending on the gear the transmission was put in, interlock with gear-specific recesses in the sliding selector shafts who, in turn, are connected with gearshift forks. These gearshift forks again are connected with the sliding collars of the gearshift packages which, for the torsion-resistant connection of loose wheels with a

gearshift shaft, are shifted axially on the respective gearshift shaft during a shifting actuation.

[014] Even though this unpublished shifting device is associated with the advantage that, for example, a double clutch transmission with the described gear and gearshift package arrangement, while keeping almost all of its components, can also be used as manual gearbox and can be shifted with an H- or multiple-H-gearshifting gate, the design of the shifting device nevertheless turns out to be mechanically costly.

[015] Therefore, the objective of the invention is to present a shifting device in the form familiar from DE 102 31 547 A1 which includes the advantages stated above, but which is less complex in its mechanical design.

[016] The solution to this objective ensues from the characteristics of the main claim, while favorable further developments and designs of the invention can be taken from the sub-claims.

[017]

[018] The shifting device, according to the invention, therefore, is intended for a multi-step transmission in which at least one gearshift package is allocated to two non-successive gear transmission ratio steps. Each of these gearshift packages is first of all coupled with a gearshift lever through sliding selector shafts and/or gearshift cable and can thus be operated. In this shifting device, a gearshifting diagram is allocated to the gearshift lever in which two successive gear transmission ratio steps are basically arranged opposite to each other in a gearshift path and in which the gear transmission ratios, which can be selected within a gearshift path, are allocated to various gearshift packages.

[019] In order to shift the described transmission with the gearshift lever in this gearshifting diagram, the gearshift lever is connected to a special mechanical conversion device. This conversion device makes it possible that a gearshift lever movement in a gearshift path intended to disengage a preceding gear also leads to a disengagement of the preceding gear in the area of a first gearshift package. Furthermore, a gearshift lever movement in the same gearshift path leads to the

engagement of a new gear, also intended for engaging this new gear in the area of a second gearshift package.

[020] According to the invention, this conversion device is structured in such a way, that the gearshift lever is only coupled to one axially displaceable and radially swiveling shift finger shaft, which penetrates the gearshift frames that are each connected with sliding selector shafts. Furthermore, at least one shift finger per gear transmission ratio step or gearshift frame is allocated to the shift finger shaft, and in each of the gearshift frames in the area of its opening there is at least one recess, which respectively is allocated to one of the shift fingers on the gearshift shaft.

[021] The simultaneous engaging and disengaging of the gears in a path occurs via opposite lying fingers on the gearshift shaft. Hereby, counter rotational, translatory movements of two shifting elements to be shifted simultaneously are generated via a gearshift shaft rotation with a constant sense of direction.

[022] When moving the gearshift lever in the selector path of the shifting device to a gearshift path position, an axial displacement of the shift finger shaft takes place, in which one of the shift fingers engages into a recess in the gearshift frame. A movement of the gearshift lever in a gearshift path, however, causes the shift finger shaft to swivel around its longitudinal axis to engage or to disengage a gear, which causes at least one shift finger to axially displace a gearshift frame and the sliding selector shafts that are connected to it.

[023] This shifting device compares quite favorably to the shifting device of the unpublished DE 102 31 547 A1 since, in contrast to this known shifting device, only one shift finger shaft in a mechanically less complex design, instead of two, is necessary to achieve the same technical result.

[024] An adaptation of the invention could be that the opening of the gearshift frames, which are connected to the sliding selector shaft and/or the circumference geometry of the gearshift frames are oval, circular or rectangular. It is a good idea to have the sliding selector shafts and the gearshift frames as one component which could thus be produced in one piece.

- [025] Moreover, it is possible to connect the sliding selector shafts with shift rockers, which respectively engage into the sliding collars of a gearshift package that has been placed on a gearbox shaft in an axially displaceable and torsion-resistant manner.
- [026] The conversion device of the invention is particularly well utilized when two shift fingers are allocated to each of the gearshift frames. Thus, the two shift fingers assigned to a gearshift frame may be arranged on the shift finger shaft at the same location or also axially successive and, in such a way, that radially, they basically point into the same or opposite directions.
- [027] For a specific gearbox, the sliding selector shafts with their gearshift frames are successively arranged in the conversion device in such a way that the gearshift frame for actuating the reverse gear and possibly for actuating a seventh gear is followed by the gearshift frame for actuating the first and third gears; the gearshift frame of the fourth and fifth gears, and the gearshift frame of the second and sixth gear.
- [028] The recess in the respective gearshift frames is preferably constructed in such a way that it consists of a gearshift contour in the shifting direction and an engine-to-body-clearance contour in opposite direction, which operate together with the correspondingly aligned gearshift contours on the shift fingers.
- [029] To guarantee that only the gear selected by the sliding selector shaft is engaged and that the associated shift finger can only be inserted at a predetermined position of the shift finger shaft into the respective recess in the gearshift frame. The design of the invention provides for the creation of recesses with preferably slanted sidewalls at the shift fingers and/or at positions where the shift finger shafts are attached to the shift fingers. A locking device engages into these recesses to release a shifting action. The locking device is preferably a catch stop at the respective gearshift frame which points to the shift finger shaft, which only allows the intended shift finger to enter into the recess of a gearshift frame.
- [030] The shifting diagram of the shifting device of the invention should preferably be in the form of an "H" or a multiple "H", with the shifting positions opposite from

each other and in which two gearshift packages are allocated to each gearshift path in the transmission.

[031] The shift finger shaft with its shift fingers, as well as the gearshift frame with respect to an especially compact design of the conversion device, are constructed in such a way that when the shift finger shaft is shifted axially, at least one shift finger is taken out of an engaging position in the recess of a gearshift frame, whereas, at the same time, at least one other shift finger inserts itself into at least one other gearshift frame, comparable to a gearshift path selection.

[032] The radial swiveling of the shift finger shaft around its longitudinal axis, however, leads to an axial displacement of at least one gearshift frame and the sliding selector shaft connected to it so that a gear can be disengaged and/or engaged. For this process, the axial movements of the stated gearshift frames can be in the same or also in the opposite direction.

[033] A different aspect of the invention is that the power transmission ratio of the shifting device can be set by designing the shifting geometry of the recess in the gearshift frame in such a way that the gear shifting forces can be adjusted for different gears. For this set-up, the only limiting factor for the maximum shifting force would be the stability of the component.

[034] In addition, a gear-specific synchronous path can be produced by varying the lengths of the shift fingers.

[035] Finally, an additional useful possible design change of the invention is that the shifting device is actuatable with the help of regulating devices instead of manually which are supported by auxiliary power, whereby the regulating devices are preferably designed as a piston-cylinder-configuration. This arrangement pertains to an automated gearbox or an automated double, clutch transmission. In such a design, one piston-cylinder-configuration is used to axially displace the shift finger shaft and another piston-cylinder-configuration swivels the shift finger shaft. Obviously, in such a suggested automated or automatic transmission, the manual selector with an H- or multiple H-gearshifting gate can be eliminated. Instead, a shifting rocker or another suitable shifting device for selecting the gears can be used.

[036] The axial distance between two gearshift frames corresponds to the width of at least one shift finger. Thereby, the goal that, on the one hand, the gearshift frames are allocated to each other in a compact form and, on the other hand, that a shift finger can swivel into the gap between two gearshift frames, if it is not needed for actuating a gearshift frame, was achieved.

[037] To further develop the invention, we suggest allowing for the gearshift lever to be able to move in the gearshifting gate when changing gears, i.e., the gearshift lever can basically be moved diagonally in the gearshift path. This is achieved in that either the contour of the gearshift frame or the contour of the engaging area of the shift fingers is constructed to allow for the gearshift lever to move diagonally. In doing so, the width of the engaging area of the shift fingers could be smaller than the width of the shift finger in the area of its hub.

[038] To further enhance the design of the invention, it is possible to position the shift finger on the shaft in such a way, that the shift fingers, when shifted into neutral gear, do not run perpendicular to the sliding selector shafts or the gearshift frames, but are positioned diagonally to the sliding selector shafts or the gearshift frames.

[039] When putting the car in gear by pushing the gearshift lever, the respective shift finger is then swiveled into a position, which is basically arranged perpendicularly to the sliding selector shaft or to the gearshift frame.

[040] To further enhance the design of the invention, it is possible to provide for a shift finger which could actuate a gearshift package or engage and disengage two gears. This shift finger would work together with a gearshift frame. The suggested compact design requires only a few parts.

[041] Advantageously, in the above described design the one shift finger for actuating of a gearshift package acts together with a recess of a gearshift frame.

[042] As opposed to the above described design with several shift fingers per gearshift frame, when dealing with the arrangement of one shift finger in a gearshift frame, it is also possible that the shift finger utilized for actuating a gearshift frame is arranged on the shift finger shaft in such a way, that the shift finger, when placed in neutral, basically runs perpendicular to the sliding selector

shaft or the gearshift frame. In order to put the car in gear by actuating the gearshift lever, the shift finger is swiveled into an angled position, which is not perpendicular to the sliding selector shaft or the gearshift frame.

[043] In the above described design of the shifting device it is, therefore, possible to shift four gears with two shift fingers.

[044] In the same way, the course of motion of a gearshift lever can be predetermined by the geometry of the gearshift frames or the catch stops so that the function of a gearshifting gate for a manual gearshift lever can be represented expediently by the gearshift frame and/or by the catch stops. Thereby, through a special construction of the shifting device, the gearshift lever can perform a basically diagonal path when changing from one gear in a gearshift path to an adjacent gear in another gearshift path.

[045] Apart from the shifting device described above, the invention also applies to motor vehicle transmissions that contain a shifting device with the characteristics described above. It is irrelevant, whether the transmission is constructed as manual gearbox with a conventional gearshift lever, such as an H-shifting diagram or as an automated gearbox or also as an automatic transmission with a selector, a shifting rocker or a similar device with suitable means of actuation.

[046] The motor vehicle transmission, if constructed according to the invention, may also be built as a countershaft transmission, which consists exclusively of loose wheels gearshift packages are allocated to those wheels and one gearbox shaft each is allocated to the packages' respective torsion-resistant connection.

[047] To further build upon the design of the invention, it is possible to construct the motor vehicle transmission as a double clutch transmission or also as a transmission with a double clutch wheel with only one start clutch.

[048]

[049] The invention is best explained with concrete examples as shown in the attached drawings.

[050] Fig. 1 shows a diagram of a car's power train;

[051] Fig. 2 shows a diagram of the construction of a double clutch transmission;

- [052] Fig. 3 shows diagram of the construction of a manual gearbox with a double clutch gearset;
- [053] Fig. 4 shows a three-dimensional view of a conversion device constructed according to the invention;
- [054] Fig. 5 shows a detailed view of a gearshift frame with its sliding selector shafts;
- [055] Fig. 6 shows a gearshift frame which is penetrated by a shift finger shaft;
- [056] Fig. 7 is an overview of the conversion device shifting from the first into the second gear;
- [057] Fig. 8 is an overview of the conversion device shifting from the third into the fourth gear;
- [058] Fig. 9 is an overview of the conversion device shifting from the fifth into the sixth gear;
- [059] Fig. 10 is an overview of the conversion device shifting into reverse gear;
- [060] Fig. 11 is a side view of two gearshift frames arranged very closely next to each other;
- [061] Fig. 12 is a gearshift frame with clearly visibly profiled catch stops;
- [062] Fig. 13 is a movement shifting diagram of a gear selector generated through measurement technology;
- [063] Fig. 14 shows a shift finger with reduced engagement width;
- [064] Fig. 15, 16 shows an alternative design of a gearshift frame with sliding selector shafts and shift fingers;
- [065] Fig. 17, 18 show an additional design of a gearshift frame with only one shift finger for two gears; and
- [066] Fig. 19 to 22 show two gearshift frames arranged closely next to each other in order to shift four gears with two shift fingers from perspective viewpoint.
- [067]
- [068] Thus, Fig. 1 shows the already known construction of a power train 30 of a vehicle with a driving motor 31, a start and shifting clutch 32 and a manual transmission 33. The transmission 33 can be operated with a manual shifting

device 34 in order to set the gear transmission ratio. The shifting device 34 has a gearshift lever 35 for this purpose, which is guided in a multiple H-gearshifting gate 36. The gearshift lever 35 of this shifting device 34 or a cable system (not shown), is also connected via a gearshift linkage with a gearshifting shaft, which is inside the transmission 33 and coupled with gearshift mediums, which can change the gear transmission ratio in the transmission.

[069] According to Fig. 1, the transmission 33, which can be operated by the shifting device 34 in order to set the gear transmission ratio, can be built as double clutch transmission (Fig. 2) or as single clutch transmission (Fig. 3). In each case, however, it is a transmission in which two gear pairs, arranged next to each other, cannot be selected in the same gearshift path by the gearshift lever 35 in the shifting device 34.

[070] Thus, Fig. 2 simply illustrates the state of the art design of a double clutch transmission, which is connected on the input side via a double clutch 37 with the driving motor 31, which is shown here as a combustion engine. To do so, the double clutch transmission has two input shafts 38, 39 on the input side, which are each connected with one clutch of the two clutches of the double clutch 37.

[071] The double clutch transmission is furthermore designed in such a way that even-numbered gears G2, G4, G6 and odd-numbered gears G1, G3 and G5 each sit on one of the two input shafts. The gear transmission ratio steps of the even gears hereby are on the first input shaft 38, which is designed as a hollow shaft, whereas the odd gears are arranged on the second input shaft 39, which is positioned inside the hollow shaft 38.

[072] The gear transmission ratios of the second and fourth gears G2, G4 are formed by loose wheels 40, 41 on the first input shaft 38, and fixed wheels 42, 43 are positioned on a countershaft 52, whereas a fixed wheel 44 on this hollow input shaft 38 and a loose wheel 45, combined with the countershaft 52, form the gear pair for the sixth gear G6.

[073] Furthermore, on the second input shaft 39, a fixed wheel 46 is in toothed engagement with a loose wheel 47 on the countershaft 52 forming the first gear G1, whereas two loose wheels 48, 49 on the second input shaft 39 combined

with fixed wheels 50, 51 on the countershaft 52 form the third gear G3 and the fifth gear G5.

[074] In order to simplify the illustration, gear tooth forming wheels for the seventh gear or the reverse gear have been omitted.

[075] So-called gearshift packages 53, 54, 55 are arranged between the loose wheels 40 41; 45, 47, as well as 48, 49, which consist mainly of sliding collars and synchronize rings, which are axially displaceable but arranged torsion-resistantly on the shafts 38, 39, 52, according to present day technology. These gearshift packages 53, 54, 55 make it possible to connect the respective loose wheels 40, 41, 45, 47, 48, 49 torsion-resistantly with the gearbox shafts 38, 39, 52, so that it is possible to add or remove individual gear transmission ratio steps.

[076] In order to be able to perform load shifts with such a double clutch transmission without interrupting the traction force, the gear ratio of the target gear is already put into the gear prior to the actual shifting action with a disengaged clutch. During the shifting action in the transmission, an overlapping gearshift occurs in which the clutch of the target gear is engaged and the clutch of the previous gears is disengaged in a parallel position to it. Here, the torque transfer of the double clutch engine torque from the previous to the new, to be engaged clutch takes place, whereby the activation of the double clutch 37, as well as the actuation devices for the sliding collars of the gearshift packages 53, 54, 55, is done automatically by a control unit, which is not shown here.

[077] Fig. 3 shows a double clutch gearset according to Fig. 2 in a manually shifted power train. Thereby, only a starting and shifting clutch 32, which is actuated by the driver and whose output side is drive-technically connected to the two input shafts 38, 39, lies between the combustion engine 31 and the transmission.

[078] Even though a single input shaft, instead of the two input shafts 38, 39, can be used for this manual transmission, the utilization of the same core transmission as in the double clutch transmission according to Fig. 2 has some cost advantages. The use of a conventional shifting device for this transmission would, however, require a shifting diagram in the gearshifting gate, which would

be unnatural for the driver. In this diagram, the gears G2 and G4 would be in one gearshift path, whereas the gears G1 and G6, as well as G3 and G5 would be allocated to different gearshift paths.

[079] Therefore, this technical problem is a starting point for the manual shifting device of this invention, which makes it possible to shift a transmission by using an H- or multiple H-gearshifting gate in which two gears in the gearshift path of the shifting device in the transmission do not come into contact with two gear wheel pairs, which are situated next to each other and can be actuated by a sliding collar. For this purpose, the shifting device of the invention is equipped with a conversion device which is shown in Fig. 4.

[080] This conversion device has a shift finger shaft 1, which is mechanically coupled with the manual gearshift lever 35, which can be displaced axially in direction of arrow 18, as well as swivelled according to arrow 19 around its longitudinal axis and is contained in a transmission case (not shown here). Shift fingers 2, 3, 4, 5, 6, 7, 8 have been mounted cam-like onto the shift finger shaft 1, facing radially outside; some of them face in the same direction, whereas other shift fingers face in the opposite direction. Furthermore, some of the shift fingers 2, 3, 4, 5, 6, 7, 8 have been mounted direct after each other or with a gap.

[081] As explained in Fig. 4, the shift finger shaft 1, respectively, inserts itself into the opening of gearshift frames 14, 15, 16, 17, which have a rectangle form in this design, at the right or left end of the gearshift frames, where sliding selector shafts 10, 11, 12, 13, 56, 57, 58, 59 are mounted. On their free end, these sliding selector shafts 10, 11, 12, 13, 56, 57, 58, 59 are connected with gearshift forks (not shown here), which engage into sliding collars of the gearshift packages 53, 54, 55.

[082] The sliding selector shafts 10, 11, 12, 13, 56, 57, 58, 59 and the gearshift frames 14, 15, 16, 17, respectively, may also be produced as one component, for example by using a flexible cutting die.

[083] The gearshift frames 14, 15, 16, 17 each have a recess 9 at their opening, in which one of the respective shift fingers 2, 3, 4, 5, 6, 7, 8 can engage coaxially to directional arrow 18 in an axial displacement of the shift finger shaft 1.

By swivelling the shift finger shaft 1 around its longitudinal axis, according to the directional arrow 19, one or several of the shift fingers 2, 3, 4, 5, 6, 7, 8 displace one or several of the gearshift frames 14, 15, 16, 17 with the sliding selector shafts 10, 11, 12, 13, 56, 57, 58, 59 attached to them, which displaces the sliding collars mentioned above in an axial manner. By systematically positioning the shift fingers 2, 3, 4, 5, 6, 7, 8 on the gearshift shaft 1, a reverse gear RG of the transmission, for example, can be activated through shift finger 9, the gearshift frame 14 and the sliding selector shaft 56.

[084] Furthermore, by producing a second recess in the gearshift frame 14, and by positioning an additional shift finger in the area of shift finger 8 on gearshift shaft 1 with the sliding selector shaft 10, the system could engage or disengage a seventh gear G7.

[085] As explained in Fig. 4 with respect to the first and third gears G1 and G3, shift fingers 2, 3, which are essentially positioned opposite each other, engage into opposing recesses on gearshift frame 15. The third gear G3 or the first gear G1 is actuatable due to the resulting axial displacement of the gear shift frame in coaxial relationship to sliding selector shafts 11, 57 that are mounted to it.

[086] For the axial displacement of gearshift frame 16, together with its sliding selector shafts 12, 58, on the shift finger shaft 1, two shift fingers shaft 4, 5 are mounted directly behind one another. They engage as selected into the recess of the gearshift frame 16 directly above them. The fourth gear G4 and the fifth gear G5 is actuated due to this design.

[087] Finally, Fig. 4 shows that the sixth gear G6 and the second gear G2 can be shifted with shift fingers 6, 7 engaging as selected into the opposite lying recesses 9, 9a of the gearshift frame 17, and with the sliding selector shafts 13, 59 when swiveling the shift finger shaft 1.

[088] Fig. 5 depicts gearshift frame 15 from the side and represents all other gearshift frames. The sliding selector shafts 11, 57 are connected to this gearshift frame 15. They can actuate the first gear G1 and the third gear G3 via the already described gearshift packages 54, 55. This illustration shows particularly well that the two recesses 9, 9a are located in the gearshift frame 15 in such a way that

they each have an essentially radially straight gearshift contour 22, 27 and a curved engine-to-body-clearance contour 20, 21.

[089] These two types of contours make it possible that shift fingers 2, 3 with similar exterior geometry (locking contour 28 and curved or an angular engine-to-body-clearance contour 29 on shift finger 6 as in Fig. 6) engaging into the respective recesses 9, 9a can move into the gearshift frame 15, and can displace it in an axis-parallel manner to directional arrow 26 to the left in order to put the transmission in third gear G3, and to the right in order to put the transmission in first gear G1. On the other hand, the engine-to-body-clearance contours 20, 21 make it possible to unscrew the shift fingers 2, 3 from the recesses 9, 9a without any problems.

[090] In as far as two shift fingers 2, 3 are supposed to engage alternatively to each other into a gearshift frame 15, the gearshift contours 22, 27 and the engine-to-body-clearance contours 20, 21 are aligned opposite to each other in the two recesses 9, 9a lying opposite to these two, as is shown in Fig. 5, in order to respectively allow the other shift finger to glide out without any problem when a gear is put in.

[091] Another way this invention can be used is shown in Fig. 6. It is possible to create a recess 23 each with angular side walls 25 at the shift fingers 6 or on the respective locations for the shift fingers on shift finger shaft 1. A locking device, preferably a catch stop 24, can engage into this recess. This catch stop 24 then forms a part of each gearshift frame and protrudes radially towards the interior of the shaft 1 or into a lateral recess 23 of the shift finger 6.

[092] The catch stop 24 makes it possible for only one specific shift finger 6 and/or a random shift finger can engage in a specific swivel position of the shift finger shaft 1 into the recess 9. In all other movements or swivel positions of the shift finger shaft 1, the respective catch stop 24 locks into the assigned recess 9 of the respective gearshift frame 17.

[093] What is particularly interesting about this conversion device is the fact that with only one camshaft (shift finger shaft 1), seven forward gears and one reverse gear can be shifted. For this purpose the shift fingers 2, 3, 4, 5, 6, 7, 8 on the shift

finger shaft 1, as well as the coupling of the sliding selector shafts 10, 11, 12, 13, 56, 57, 58, 59 with the sliding collars of the gearshift packages 53, 54, 55 are selected and aligned in such a way, that when gearshift lever 35 in the gearshift path of the shifting device 34 takes out a gear, first of all, a gear in the transmission is taken out through a first gearshift frame. When shifting to the next gear in the same path of the shifting device 34, an additional parallel rotation of the shift finger shaft 1 in the same rotational direction occurs, which puts the other gear of the same gearshift path in the transmission into gear by using a second gearshift frame.

[094] As is shown in Fig. 7, when a gear is shifted in the same gearshift path from first gear G1 to second gear G2, the shift finger shaft 1 is positioned in the openings of the two gearshift frames 15, 17 in such a way, that shift finger 3 and shift finger 7 are inserted into the recesses of the gearshift frames 15, 17. Swiveling the shift finger shaft 1 to the right moves the gearshift frame 15 together with the sliding selector shaft 11 to the left into neutral, so that the first gear G1 is taken out. At the same time, by displacing the gearshift frame 17, shift finger 7 moves, together with the sliding selector shaft 13, moves from a neutral position to the right so that the second gear G2 can be put in.

[095] Though, according to Fig. 8, shifting from the third gear G3 into the fourth gear G4 does not occur according to the same pattern, in this case the two gearshift frames 15, 16 move to the right side by swiveling the shift finger shaft 1 to the left (arrow 19). This way, shift fingers 2, 5 take out the third gear G3 and bring it to the neutral position, which puts in the fourth gear G4.

[096] As shown in Fig. 9, for shifting from the fifth gear G5 into the sixth gear G6, the shift finger shaft 1 is displaced axially according to directional arrow 18 in the openings of the gearshift frames 16, 17 in such a way that shift fingers 4, 6 engage into the recesses of the gearshift frames 16, 17 assigned to them. A swivelling of the shift finger shaft 1 to the right according to directional arrow 19 has the result, that the gearshift contour 28 of the shift finger 6 lies against the gearshift contour of the gearshift frame 17 (Fig. 6). In order to put the car into sixth gear G6, the gearshift contour transports gearshift frame together with the sliding selector

shaft 59 to the left, from a neutral position into the shifting position, whereas the shift finger 4 engages with its gearshift contour into the gearshift contour of the gearshift frame 16 and displaces this gearshift frame 17 to the right for taking out the fifth gear G5.

[097] Finally, Fig. 10 shows the conversion device in a shifting position in which the shift finger shaft 1 is displaced axially so far in direction of directional arrow 18 by an according path selection of the gearshift lever 35 in the shifting device 34, that the shift finger 8 engages into a recess in the gearshift frame 14. When swivelling the shift finger shaft 1 to the left according to directional arrow 19, the shift finger 8 pushes the gearshift frame 14 with its sliding selector shaft 56 to the left, so that the reverse gear RG is put in.

[098] However, this Fig. 10 also indicates, that the right side of the gearshift frame 14 may also be connected with a sliding selector shaft 10 through which, for example, the seventh gear G7 of a seven-gear transmission can be shifted. For this purpose, merely an additional recess has to be positioned in the gearshift frame 14 and an additional shift finger has to be positioned on the shift finger shaft.

[099] If the gears in the transmission are in a difficult position, it may be necessary to have the same number of gears as there are shift fingers. If the gears in the design of the transmission are, however, designed so that the respective second gear is in the same shifting direction, four gears can be shifted with two shift fingers, since the gearshift path has to be changed. As is shown in Fig. 11, this reduces the minimum distance between two gearshift frames from three times the shift finger width to one shift finger width.

[100] The conversion device can be extremely short as shown in Fig. 11. In this version of the invention, two gearshift frames 60, 61, used for shifting the fifth and sixth gears, are arranged so tightly behind each other or the third and first gears, that their axial distance merely corresponds to one shift finger hub width. This design makes it possible to shift the seventh gear with a shift finger 62 located on the shift finger shaft 1, engaging into the recess 63 of the gearshift frame 60 and by swivelling the shift finger shaft 1 according to directional arrow 19, and the fifth

gear can be shifted with shift finger 86, which is arranged axially at the same site on the shift finger shaft 1 and which points into the opposite direction.

[101] For shifting the first or third gear, the shift finger shaft 1 is displaced axially in direction 18 by one shift finger width, so that for shifting the first gear, a shift finger 65 can insert itself into a recess 67 of the gearshift frame 61, and the gearshift shaft can be swiveled axially. For putting the transmission into third gear, the shift finger shaft 1 is kept axially at the same position and is swiveled into the opposite direction according to directional arrow 19, so that a shift finger (not shown here) can penetrate a recess 64 of the gearshift frame 61 and displace it to the right.

[102] With respect to the catch stop geometry, the illustration of a gearshift frame 68 in Fig. 12 clarifies that the surface contours 71, 72, 73 of the catch stops 71, 72, apart from their function to release a shift finger for penetrating into the gearshift frame, also influence the shifting geometry, through which a gearshift lever can be displaced in its gearshifting gate.

[103] Fig. 13 shows a course of motion 74 of a gearshift lever 35, based on some measurements, which is connected with a conversion device of the invention, in its gearshifting gate 36.

[104] As is easily visible, this gearshifting gate 36 is constructed as HH-gear shifting gate, in which the gearshift lever 35 can be moved in a selector path 75, and four gearshift paths. The shifting actions in gearshift paths 76, 77, 78 for shifting the first to sixth gear G1 to G6 clearly shows that the contours 71, 72, 73 of catch stops 69, 70 influences the shape of the diagonal shifting diagram 79, 80 in such a way that, especially when changing from one gearshift path G1-G2 to the next gearshift path G2-G3, the surface feel can be positively influenced by the driver.

[105] Finally, Fig. 14 shows, that for producing an easy shifting action, each or also only a few of the shift fingers 81 have a smaller component width 83 around their area of engagement 82 than around their hub or the opening 85 through which the shift finger 81 is drawn onto the shift finger shaft 1. Furthermore, the component width 83 in the engagement area 82 of the shift finger 81 should be

smaller than a width 86 of the gearshift frame 68. In addition, the engagement area 82 of the shift finger 81, either by itself or in collaboration with the catch stop geometry 71, 72, 73, can be constructed in such a way that the catch stops 69, 70 in the selector path 75 make a diagonal shift possible or at least support the same.

[106] Of course the shifting device of the invention may also be used for shifting a transmission in which loose wheels are exclusively arranged on the gearshift shafts which can, for example by means of the described coupling devices of synchronize rings and sliding collars, are connected torsion-resistantly with the shafts.

[107] In a further variation of the invention (Figs. 15, 16), a shift finger shaft 87, whose shift fingers 88, 89 are not arranged perpendicularly in recesses 97, 98 of a gearshift frame 92 or not perpendicularly to a sliding selector shafts 93, 94 in a neutral position of the transmission is shown. The shift fingers 88, 89 are essentially positioned diametrically to each other and axially staggered to each other on the shift finger shaft 87. Locking fingers 90, 91 are also positioned diametrically to each other, however, swiveled by an angle to the axis of the shift fingers 88, 89 on the shift finger shaft 87. These locking fingers 90, 91 act together with catch stops 95, 96, which join the sliding selector shafts 93, 94 in the interior of gearshift frame 92. The gearshift frame 92 laterally has the recess 97 with a ramp-shaped bezel 99 so that a gearshifting gate can be reproduced by gliding the shift finger 88 on the ramp 99. This gate function can alternatively be done by using ramps on the catch stops 95, 96, if these act together with the shift fingers 90, 91. In the position shown in Fig. 15, the shift fingers 88, 89 are in neutral position in the recesses 97, 98. This is necessary since the rotation, for example, when shifting from the second into the third gear, has to continue in opposite direction of a shown direction of rotation 100, so that the shift finger for the third gear (not shown here) can displace the corresponding gearshift frame, and the shift finger 89 for the second gear can swivel out of the recess 98 of the gearshift frame 92 for the second gear.

[108] For putting the transmission into second gear, for example (Fig. 16), the shift finger shaft 87 is rotated further into the direction of rotation 100, so that the

shift finger 89 swivels into the recess 98 for the second gear, and the gearshift frame 92 is shifted to the left in direction 101. In second gear, the shift finger 89 is perpendicular to the axis of the gearshift frame 92 or to the axes of the sliding selector shafts 93, 94. The corresponding shift finger 88 for the fourth gear is in one level in front of the gearshift frame 92 and can, therefore, be swivelled upward vertically. The reverse sequence is performed to take the transmission out of second gear and the shift finger shaft 87 is rotated against the shown direction of rotation 100 until the shift finger 89 swivels out of the recess 98 (see also Fig. 15).

[109] Another development (Figs. 17, 18) of the invention suggests to only have one shift finger 103 to actuating a gearshift package or to put the transmission in or out of two gears (for example, gear five and six) and acts together with gearshift frame 107. In neutral position, the shift finger 103 is in recess 112 of the gearshift frame 107 and the locking fingers 105, 106 lock catch stops 110, 111, so that the gearshift frame 107 cannot be displaced. When turning a shift finger shaft 102 in the direction of rotation 115, the shift finger 103 swivels into recess 112 to the left, so that the gearshift frame 107 is displaced in direction 116 and the fifth gear is put in. During this swivel movement of the shift finger shaft 102, the locking finger 105 swivels into a level in front of a stop catch 110. A shift finger 104, as well as the locking finger 106, is not engaged when the fifth gear is put in.

[110] For taking the fifth gear out, the shift finger shaft 102 is rotated against the shown direction of rotation 115 to the right, so that the shift finger 103 displaces the gearshift frame 102 against the shown direction 116 to the right into neutral position (Fig. 17).

[111] In the Figs, 19 to 22 below, we illustrate another interesting aspect of the invention, which makes four gears shiftable by way of two shift fingers. Characteristic for such a design of the shifting device are two gearshift frames 121, 122 arranged closely together, which act together with two shift fingers 118, 129 that are positioned axially staggered to each other on a shift finger shaft 117. Such a shifting device may be used when, for example, the odd-numbered gears one, three, five (seven) are situated this way on an input shaft and the even-numbered gears two, four, six, as well as the reverse gear are

situated this way on the other input shaft. In the neutral position shown in Fig. 19, the shift finger 118 is in a recess 124 for the first gear, whereas locking fingers 119, 120 are in contact with a catch stop 123, 124, making the gearshift frame 121 fixed and not displaceable. For example, to put the engine into first gear, the shift finger shaft 117 is rotated in the direction of rotation 127, so that, on the one hand, the locking fingers 119, 120 release the catch stop and, on the other hand, the shift finger 118 displaces the gearshift frame 121 in direction 128 so that the first gear is put in (Fig. 19).

[112] To take the engine out of the first gear, a rotation of the shift finger shaft 117 occurs against the shown direction of rotation 127, until the shift finger 118 is again in the position shown in Fig. 19, in which it can swivel upwards against the shown direction of rotation 127 out of the recess 124 of the gearshift frame 121.

[113] For putting the engine into third gear (Fig. 20), the shift finger shaft 117 is moved by one shift finger width axially in direction 130. Thus, the shift finger 118 and locking fingers 119, 120 disengage from the corresponding recesses and catch stop 123, 124, and thereby are on the same level in front of the gearshift frame 121. The "back" shift finger 129 can thereby insert itself into a recess 125 for the third gear. By swiveling the shift finger shaft 117 in direction 127, the shift finger 129 swivels the gearshift frame 121 in direction 131 to the right so that the third gear can be put in. To take out the third gear, the reverse happens against the demonstrated direction of rotation 127.

[114] A rear view of the gearshift frame 121, 122, according to Figs. 19 and 20, is shown in Figs. 21 and 22, so that only the gearshift frame 122 is visible as a front gearshift frame. In gearshift frame 122, recesses 124, 125 are arranged so that they can shift the fifth or seventh gear. In order to shift the fifth gear, the now in the "back" lying shift finger 118 is in the recess 124 (Fig. 21). The shift finger 129, as well as locking fingers 131, 132 are on one level in front of the gearshift frame 122. By rotating the shift finger shaft 117 in direction 127 counterclockwise, the shift finger 118 is swivelled in such a way that it displaces the gearshift frame 122 in direction 128 to the right and the fifth gear is put in.

[115] For shifting the seventh gear (Fig. 22), the shift finger shaft 117 is shifted by one shift finger width in direction 130 in such a way that the shift finger 129 inserts itself into the recess 125 of the gearshift frame 122. This way, the locking fingers 131, 132 are in contact with catch stops 133, 134 of the gearshift frame 122. By rotating the shift finger shaft 117 in clockwise direction 127, the gearshift frame 122 is shifted to the left in direction 131, and the seventh gear is put in. Taking out of the fifth or seventh gear takes place as described, but in reverse sequence.

Reference numerals

1	shift finger shaft	27	gearshift contour
2	shift finger	28	gearshift contour on shift finger
3	shift finger	29	engine-to-body-clearance contour on shift finger
4	shift finger	30	power train
5	shift finger	31	engine
6	shift finger	32	clutch
7	shift finger	33	transmission
8	shift finger	34	shifting device
9	recess	35	gearshift lever
9a	recess	36	gearshifting gate
10	sliding selector shaft	37	double clutch
11	sliding selector shaft	38	input shaft; hollow shaft
12	sliding selector shaft	39	input shaft
13	sliding selector shaft	40	loose wheel
14	gearshift frame	41	loose wheel
15	gearshift frame	42	fixed wheel
16	gearshift frame	43	fixed wheel
17	gearshift frame	44	fixed wheel
18	axial displacement	45	lose wheel
19	twisting direction	46	fixed wheel
20	engine-to-body-clearance contour	47	loose wheel
21	gearshift contour	48	loose wheel
22	engine-to-body-clearance contour	49	loose wheel
23	recess	50	fixed wheel
24	locking device	51	fixed wheel
25	sidewall of recess	52	countershaft
26	directional arrow	53	gearshift package
		54	gearshift package
		55	gearshift package

56	sliding selector shaft	87	shift finger shaft
57	sliding selector shaft	88	shift finger
58	sliding selector shaft	89	shift finger
59	sliding selector shaft	90	locking finger
60	gearshift frame	91	locking finger
61	gearshift frame	92	gearshift frame
62	shift finger	93	sliding selector shaft
63	recess	94	sliding selector shaft
64	recess	95	catch stop
65	shift finger	96	catch stop
66	recess	97	recess
67	recess	98	recess
68	gearshift frame	99	ramp
69	catch stop	100	direction of rotation
70	catch stop	101	sliding direction
71	catch stop contour	102	shift finger shaft
72	catch stop contour	103	shift finger
73	catch stop contour	104	shift finger
74	course of motion	105	locking finger
75	selector path	106	locking finger
76	gearshift path	107	gearshift frame
77	gearshift path	108	sliding selector shaft
78	gearshift path	109	sliding selector shaft
79	diagonal shifting diagram	110	catch stop
80	diagonal shifting diagram	111	catch stop
81	shift finger	112	recess
82	area of engagement	113	ramp
83	component width	114	ramp
84	component width	115	direction of rotation
85	opening	116	sliding direction
86	component width	117	shift finger shaft

118	shift finger	G1	first gear
119	locking finger	G2	Second gear
120	locking finger	G3	third gear
121	gearshift frame	G4	fourth gear
122	gearshift frame	G5	fifth gear
123	catch stop	G6	sixth gear
124	recess	G7	seventh gear
125	recess	RG	reverse gear
126	ramp		
127	direction of rotation		
128	sliding direction		
129	shift finger		
130	sliding direction		
131	locking finger		
132	locking finger		
133	catch stop		
134	catch stop		